**ULDB Systems Definition Review**

# *ULDB Mission Operations*

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# *Mission Operations Phases*

- **Mission Planning**
- **Integration & Testing**
- **Launch Operations**
- **Flight Monitor & Control**
- **Recovery Operations**

# *Mission Planning*

## Trajectory Planning

- **Requirements**
  - Evaluate Success Probabilities
    - Latitude Requirements
    - Time of Year
    - Balloon & Trajectory Control Performance
    - Safety Risk Analysis
  - Program / Mission Planning (1-2 years out)
    - Science Requirements
    - Establish International Agreements (Concurrence)
    - Launch Site Selection
  - Mission Operations (days - weeks)
    - What-If Predictions
    - Event Based Modeling
    - Launch and Termination Decisions



# *Mission Planning*

## Trajectory Planning

- **Options**
  - Traditional Analysis Methods - NMC / MRN Data
    - Manpower Intensive
  - Simulation & Planning Tool
    - Automated Data Collection / New (Additional) Data Sources
    - Analysis & Prediction
    - Graphical Display on Single / Multiple Traj. Plots
  - Southern Hemisphere Seasonal Opportunities
    - Austral Summer Versus Austral Winter

# *Mission Planning*

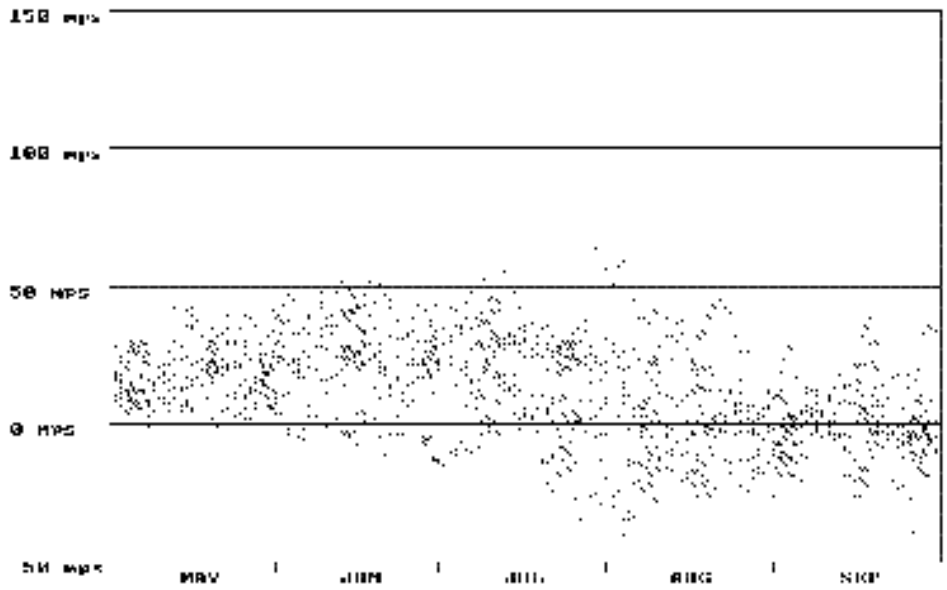
## Trajectory Planning

- **Selected Approach**
  - Simulation & Planning Tool
    - Phase I Feasibility
      - GSFC DAO & UKMO Data Sets
    - Phase II Analysis (In Progress)
      - Verification of Accuracy
      - Launch Site / Launch Date Analysis
      - Overflight Analysis
      - Thermal Environmental Analysis
    - Phase III Trajectory Simulation Tool
      - Workstation / Simulation Runs / What-If Scenarios
  - Southern Hemisphere Summer Season
    - Winter Season Trade Study Indicates:
      - Trajectory Uncertainty Due To Strat-Warms
      - Impossible to Perform Long Term Predictions
      - Difficult for Short Term Predictions

# *Mission Planning*

## Trajectory Planning

- **Southern Hemisphere Winter Wind Speeds**

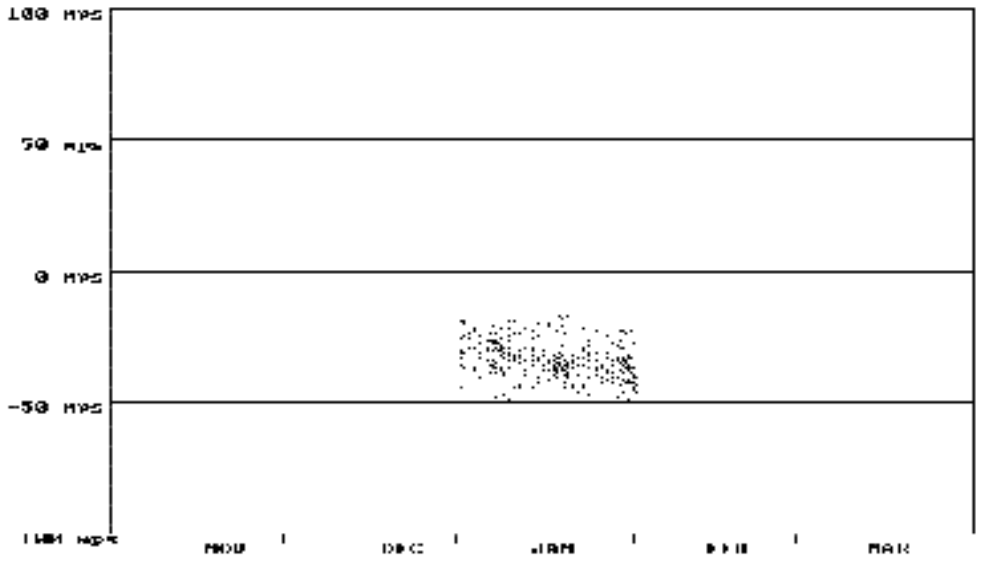



Alice Springs 5 Mb Winds

# *Mission Planning*

## Trajectory Planning

- **Southern Hemisphere Summer Wind Speeds**

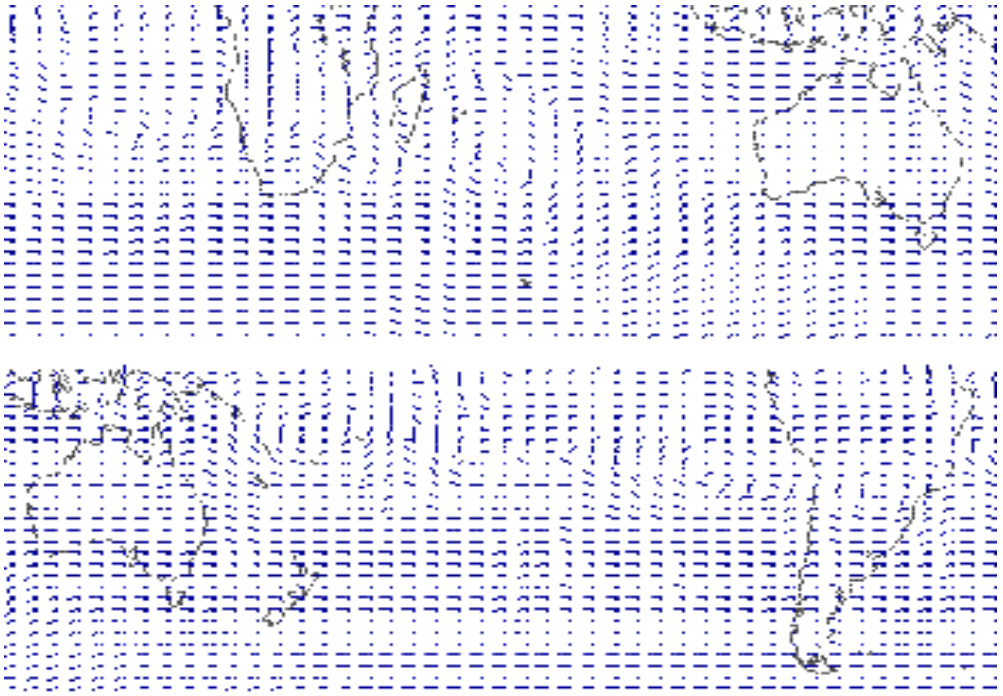



Alice Springs 5 Mb Winds

# *Mission Planning*

## Trajectory Planning

- **Southern Hemisphere Winter Zonal Flow**

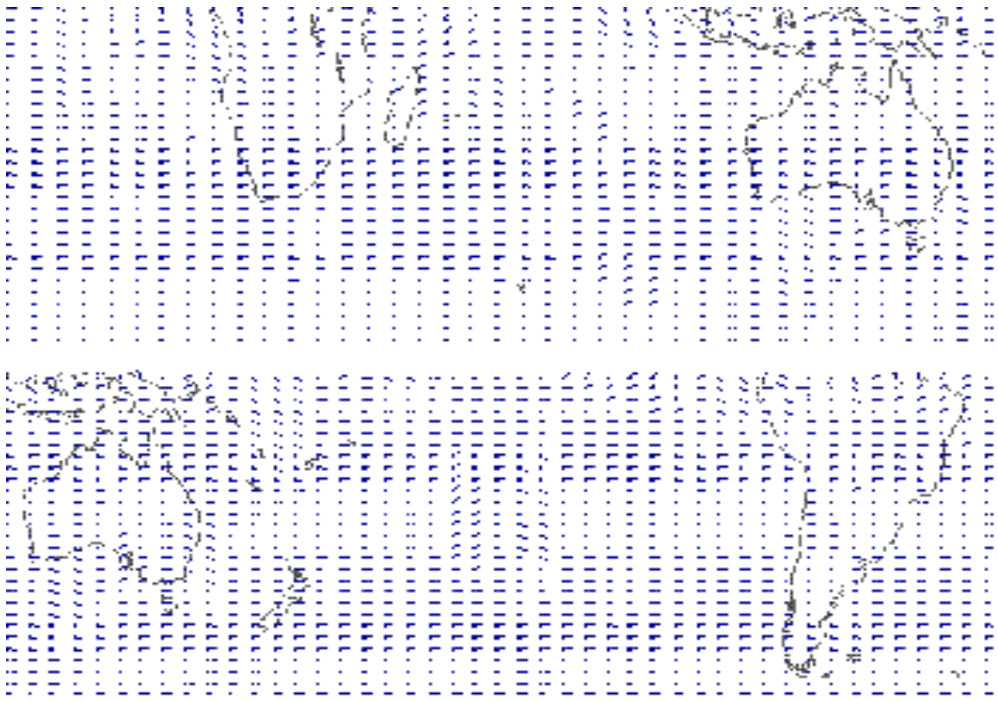


5 Mb wind Flow 15 July 1993

# *Mission Planning*

## Trajectory Planning

- **Southern Hemisphere Summer Zonal Flow**
  - Higher Probability of Recovery



5 Mb Wind Flow 15 January 1993

# *Mission Planning*

## Mission Safety

- **Requirements**
  - Acceptable CE ($1 \times 10^{-6}$) Risk Analysis
    - Balloon Reliability
    - Areas of Overflight / Reliability in Traj. Prediction
    - Recovery Systems / Impact Location Prediction
    - Balloncraft Support Systems
- **Options**
  - Overflight of Lower Risk Regions
  - Enhanced Trajectory Planning / Reliability / Launch Site
  - Balloon Reliability
  - Enhanced Recovery Systems
    - GPS Guided Parafoil
    - Dropsondes to Enhance Descent Vector
  - Balloncraft Support Systems
    - Redundancy
    - Global TM/Command With Balloncraft

# *Mission Planning*

## Mission Safety

- **Selected Approach**
  - Final CE TBD
    - Many Variables Still OPEN
  - Feasibility
    - Existing CE Alice Springs-Brazil, Summer LDB Flights
      - Existing 29X ZPB, (Assume ULDB Equal or Better)
      - Established Procedures
  - Possible Enhancements For Improved CE:
    - Trajectory Planning Tool (In Phase 2 of 3)
    - GPS Guided Parafoil
    - Dropsonde
    - Balloncraft Support Systems Redundancy / Global TM
    - Balloon Reliability (Demonstrated Prior To Demo 2000)
    - Southern Hemisphere, Lower Risk Trajectory
    - Air Surveillance Prior To Termination

# *Mission Planning*

## Launch Site Selection

- **Requirements**
  - Science & Mission Requirements
  - Safety
  - Ease of Logistics / Minimize Costs / Obtain MOUs
  - International Approvals
  - Probability for Successful Recovery
- **Options for Demo 2000**
  - Established LDB Operations From:
    - Australia / New Zealand / Alaska / Antarctica
  - Alternate Launch Sites In So. Brazil

# *Mission Planning*

## Launch Site Selection

- **Selected Approach**
  - So. Brazil CE on Balloon Ascent Unacceptable
    - Risk On Ascent After Launch
      - Highest Risks on Ascent & Initial Float Phase
      - Unplanned, Less Control Over Impact Location
    - Acceptable for Planned Termination
      - Controlled, Planned Impact
  - Alice Springs OR New Zealand (TBD)
    - Established Facilities
    - Acceptable CE For LDB
    - Alice Springs Better Strategically For Recovery
      - Greater Percentage Of Time Over Land
    - Existing MOU With Australia

# *Mission Planning*

## International Agreement

- **Requirements**
  - Launch
  - Overflight
  - Impact & Recovery
- **Options**
  - Orientation Meeting W/Code-I & NASA Export Office
  - Established Precedence From LDB
  - Pursue N.Hem. or Alternate Areas of Over-flight
    - Trajectory Planning Tool
    - Establish CE Variables
    - Demonstrated Capability
- **Selected Approach**
  - Code-I Is Planning This Coordination
  - Existing MOU W/Univ. New South Wales (Australia)
  - No Known Constraints At This Time

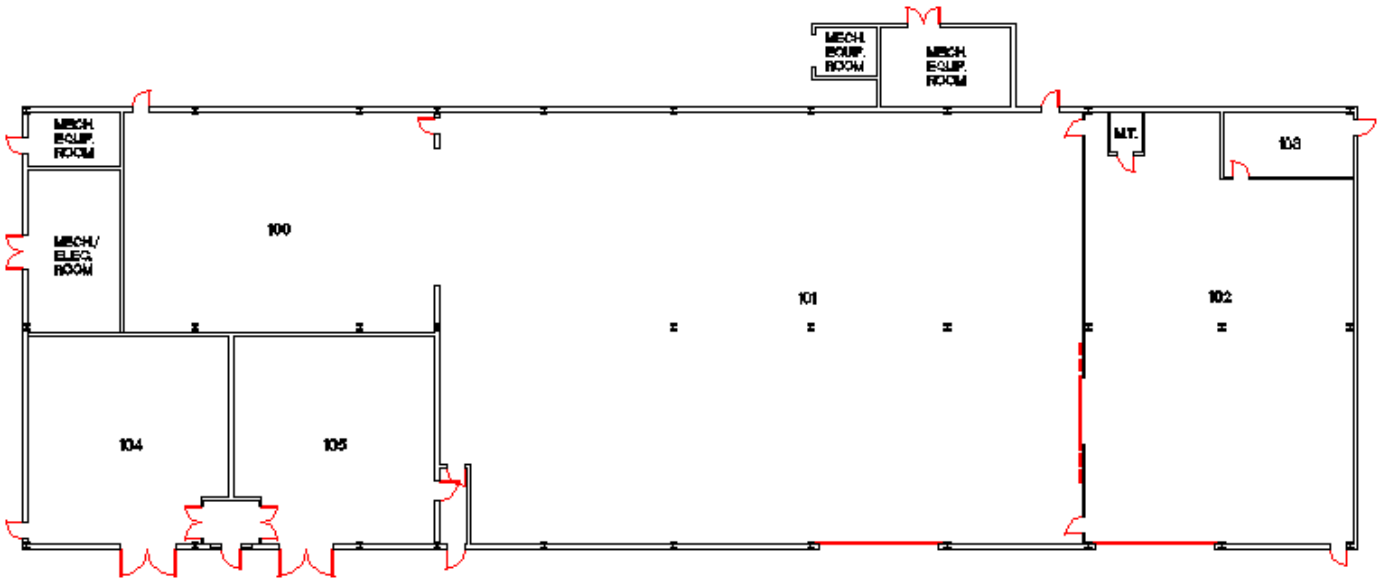
# *Integration & Test*

- **Requirements**
  - Support Personnel
  - Facilities
  - Environmental Testing
  - Telemetry / Test
- **Options**
  - Personnel
    - Science / Wallops / NSBF / Other Contract
  - Facilities
    - Wallops / NSBF / Science Home Institution
  - Environmental Testing
    - Wallops / GSFC / NSBF
  - Telemetry / Test
    - Wallops / NSBF

# *Integration & Test*

- **Selected Approach**
  - Personnel
    - Principally Science & Wallops Integration Team
    - Augmented w/Contract As Required
    - Consistent With Program Directives
    - Lowest Impact Upon Existing Balloon Program Support
  - Facilities
    - Wallops Offers Three Areas for I&T
      - Bldgs. F10 / M20 / M16 (No Cost)
      - I&T Primarily Supported By Wallops Personnel
      - M16 & M20 Available For Long Term Use
      - Best Accommodates Most Personnel Involved In I&T

# *I&T Facilities*

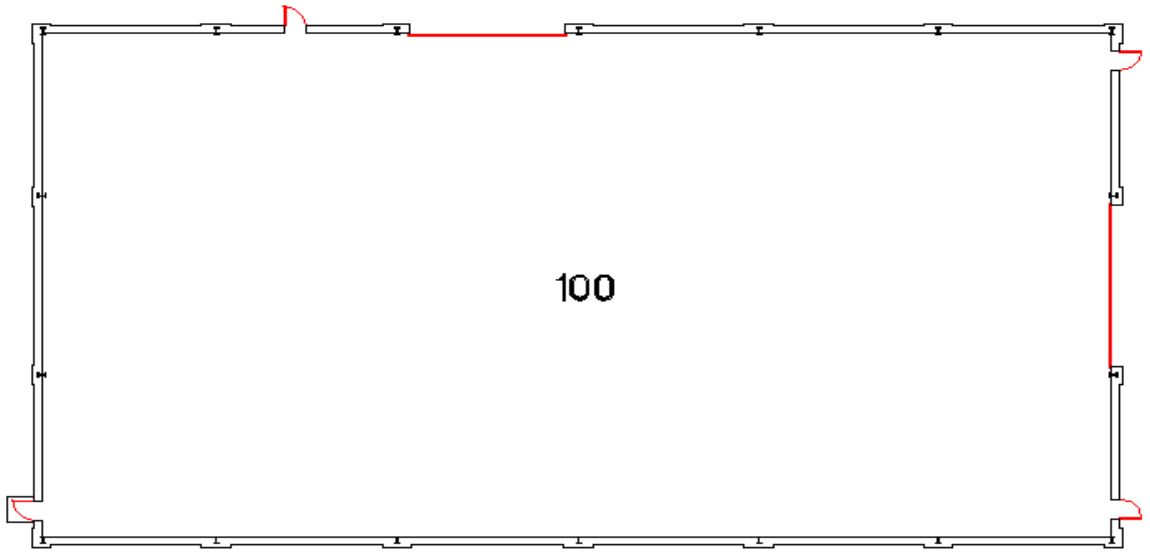



BUILDING NO. M-16

GRAPHIC SCALE IN FEET

FIRST FLOOR PLAN

# *I&T Facilities*




FIRST FLOOR PLAN

BUILDING NO. M-20

0 20 40

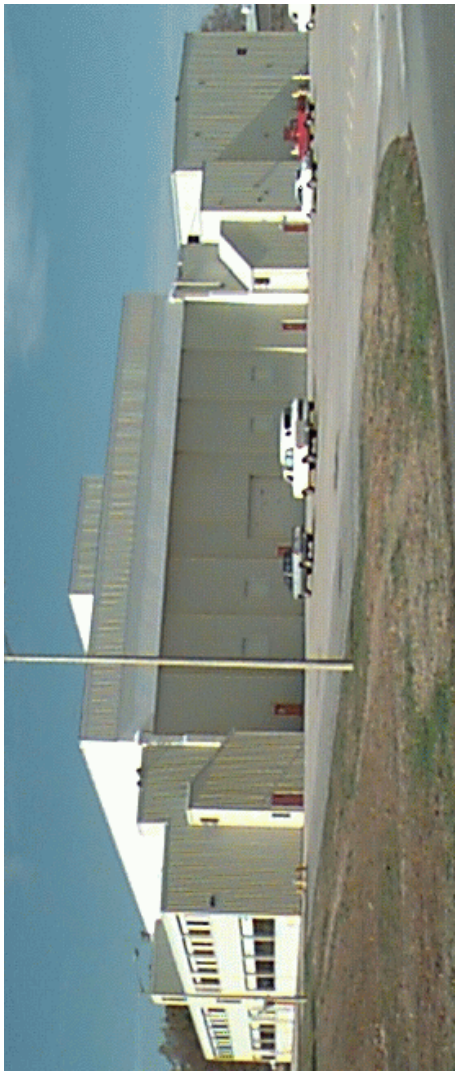
GRAPHIC SCALE IN FEET

# *I&T Facilities*

**ULDB Systems Definition Review**

**Mission Operations**

BUILDING NO. F-10





# *Integration & Test*

- **Selected Approach**
  - Environmental Test
    - Bldg. F10 Environmental (Subsystem Testing)
      - 2 ea. 2’ X 2’ Thermal / Vacuum
      - 7 ea. 1’ X 2’ Thermal / Vacuum
      - 1 ea. 7’ X 12’ Vacuum
    - GSFC (Full Up Testing)
      - 238 Chamber
        - 12’ cylindrical X 15’
        - -90 deg. C to +90 deg. C
        - Atm to <1 millibar
    - NSBF (Alternate)
      - Bemco ~6’ X 6’ X 7’ Thermal / Vacuum
        - -100 C to + 70 C
        - Atm to 0.7 millibar

# *Integration & Test*

- **Selected Approach**
  - Telemetry / Test
    - LOS RF Test Station Bldg. F10
    - Push End-to-End TDRSS Data Via INTERNET
    - TDRSS RF Test Set (TURFTS)
    - Argos / INMARSAT-C / Iridium / Argos Network Routed
    - Budgeted For Test Equipment

# *Launch Operations*

- **Requirements**
  - Personnel
  - Launch Equipment
  - LOS Telemetry Ground Stations
  - Facilities
- **Options**
  - Personnel
    - Launch - NSBF
    - Balloncraft Readiness - Integrated Payload Team
  - Launch Equipment - NSBF
  - TM Ground Station - NSBF or Wallops Supported or New Procurement of Equipment
  - Facilities - Existing (Alice Springs) or Leased (New Zealand) TBD

# *Launch Operations*

- **Selected Approach**
  - Personnel
    - Launch Conducted By NSBF
      - They’re The Experts
      - Programmatically Consistent With NASA Balloon Program Operations
    - Augmented By I&T Team For Balloncraft Preps & Flight Monitoring and Control
  - Launch Equipment
    - Standard Launch Method
      - Crane Launch
      - Standard Launch Techniques Using 36” Spool
      - Careful Metering of Inflation
  - LOS Ground Stations
    - NSBF Provided; L/S-Band / PCM / UHF Command
    - Difficulty Planning On Wallops TM Supt. Scheduling
    - Voice / Data Link Between OCC & Launch Site

# *Flight Monitor & Control*

- **Requirements**
  - Flight Management
    - Continuous, 24 Hrs/Day
  - Trajectory Analysis & Control
    - Continuous Throughout Flight
  - Personnel
  - Telemetry Ground Station
  - Facilities
    - Operational Control Center
    - INTERNET
    - Power
    - TDRSS POCC Support

# *Flight Monitor & Control*

- **Options**
  - Flight Management
    - NASA
    - NSBF
  - Trajectory Analysis & Control
    - Conventional NSBF Methods
    - Trajectory Simulator
    - Balloon Control Methods
  - Personnel Manning
    - NASA / NSBF / Science Investigators
  - Telemetry Ground Station
    - New / Existing / Developed
  - Facilities
    - NSBF / WFF / New



# *Flight Monitor & Control*

- **Selected Approach**
  - Flight Management
    - NSBF Has Mission & Flight Management Responsibility
    - NASA Has Program Management Responsibility
    - Science PI Has Instrument Responsibility - Normally Coordinates With Flight Director or Operations Manager
  - Real Time Trajectory Analysis & Control
    - Trajectory Simulator
      - What If / Near Real Time Predications
    - NSBF Met Support
      - Augment and Verify Trajectory Simulator
    - ULDB Developed Control Methods
      - Valving / Ballasting



# *Flight Monitor & Control*

- **Selected Approach**
  - Personnel
    - NSBF Mission Management & Flight Director Control
      - On Call 24 Hrs/Day
    - Control Center Operations
      - NSBF With Wallops Augmentation
        - Two People Manning 24 Hrs/Day
        - TDRSS Scheduling
        - Balloncraft Monitoring
    - Science Investigator Coordinates With NSBF Flight Director OR Operations Manager. Normally at Home Institution Accessing Data/Commands via INTERNET

# *Flight Monitor & Control*

- **Selected Approach**
  - Telemetry Ground Station
    - TDRSS POCC
      - Mission Planning Terminal / Data / Command
      - Add POCC Terminal(s) To Existing Systems
      - Multicast From White Sands For Redundancy & Distribution
    - INMARSAT / Argos / Iridium
      - Local Terminal (INMARSAT Commands)
      - Data Delivery Via Internet
    - File Server Data Archive
      - NSBF Primary / WFF Backup
        - Both Servers Operate Concurrently
        - Mitigate Risk of Network Outage

# *Flight Monitor & Control*

- **Selected Approach**
  - Facility @ NSBF
    - Space Available For Monitor & Control Center Equip.
    - Established TDRSS POCC
      - No Additional Network Infrastructure Required
    - Power Backup / UPS / Generator
    - Compatibility With LDB Systems
      - Level of Redundancy
        - POCC
        - INMARSAT Terminals
    - Flight Operations & Monitoring Personnel Based @ NSBF

# *Termination & Recovery*

- **Requirements**
  - Facilitate / Implement Safe Termination
  - Clear / Access To Balloncraft & Balloon Impact Site
  - Recover Balloncraft & Balloon Carcass
  - Arrange Return Shipment
  - Remote Communications With Control Center
  - Remote TM/CMD Access With Balloncraft
  - Recovery Tools & Equipment

# *Termination & Recovery*

- **Selected Approach**
  - Termination
    - Planned Dry Land Recovery
      - Export Office Recommendation
    - Via Operation Control Center or Recovery Team (TBD)
      - Safety Requirements
      - Accuracy of Recovery Systems
        - Dropsonde / Enhanced Descent Vectors
      - Accuracy of Trajectory Analysis
  - Recovery Team
    - 2-3 Man Field Team
    - Field Voice & Data Communications With Control Center
    - Portable LOS TM/CMD System For Balloon Control
    - Lease Aircraft Surveillance Prior to Termination (TBD)
      - Safety
    - Lease Recovery Vehicles As Required
    - Arrange Return Shipment

# *Summary*

- **Mission Planning**
  - Enhanced Trajectory Planning
  - Southern Hemisphere Summer
  - Based On LDB, Feasible CE Risk
  - Code-I Aware of Plans & Assessing Approach
  - Alice Springs or New Zealand (TBD)
- **Integration & Test**
  - Final I&T Conducted at Wallops
  - Supported Using Wallops Personnel
- **Launch Operations**
  - Conducted By NSBF
  - Augmented By Wallops For Balloncraft Readiness
  - LOS TM/CMD Provided By NSBF

# *Summary*

- **Flight Monitor & Control**
  - Located at NSBF / Existing Infrastructure
  - Manned By NSBF & Wallops (Demo 2000)
  - PI Access Data/Command Via Internet
  - Trajectory Simulation Tool Planning Aids
- **Termination & Recovery**
  - Plan Dry Land Impact
  - Australia or Brazil (Demo 2000)
  - Control From OCC / Execute From OCC or Field
  - Remote Global Communications In The Field
  - Lease Aircraft Still Optional